Report for 2004NE72B: Remediation of PCB-Contaminated Soils and Sediment using Zerovalent Iron and Surfactants

- unclassified:
  - None at present

Report Follows

Remediation of PCB-Contaminated Soils and Sediment using Zerovalent Iron and Surfactants

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Abstract

Polychlorinated biphenyls (PCBs) contaminated sediments remain a significant threat to humans and aquatic ecosystems. PCBs had been used as coolants and lubricants in transformers, capacitors, and other electrical equipment because they do not burn easily and are good insulators. The traditional methods of excavation or dredging followed by landfill disposal or incineration of PCB-contaminated soil and lake sediments involve high costs. An alternative ex-situ treatment of PCB-laden sediments is by abiotically treating the dewatered sediment with zerovalent iron (Fe^0), surfactants and additional catalysts in static unsaturated windrows. Experiments show that solubility of PCBs in water can be increased by addition of surfactants. Solubility experiments revealed that apparent solubility of PCB congeners 2,2',5 Trichlorobiphenyl and 2,4' Dichlorobiphenyl could be increased with the increasing Didecyl concentrations (up to 1%). Low concentrations of Didecyl (0.25%) also increased the mass of Aroclor 1260 (commercial mixture) that dissolved in water (30 mg out of 50 mg placed in 100 mL water). Experiments with Aroclor1260 and Fe^0 alone in a surfactant matrix indicate adsorption of Aroclor1260. Experiments with Aroclor1260, Fe^0, didecyl, and catalyst ($Al_2(SO_4)_3$) indicates rapid removal of PCBs from solution but most of this loss is a result of adsorption. Increased removal rates were obtained when Pd was used as catalyst. Ongoing experiments are now combining zerovalent iron reduction with a secondary treatment involving peroxide or permanganate to oxidize adsorbed PCB from iron surface.

Objectives

- Increase aqueous solubility of different PCBs with surfactant and quantify optimum concentration needed.
- Determine effectiveness of zero-valent iron (Fe0) to degrade/adsorb PCBs in the presence of surfactant and catalyst.

Results

Results showed that aluminum sulfate can accelerate removal of PCBs by zerovalent iron from solution (Figure 1) containing a cationic surfactant matrix.

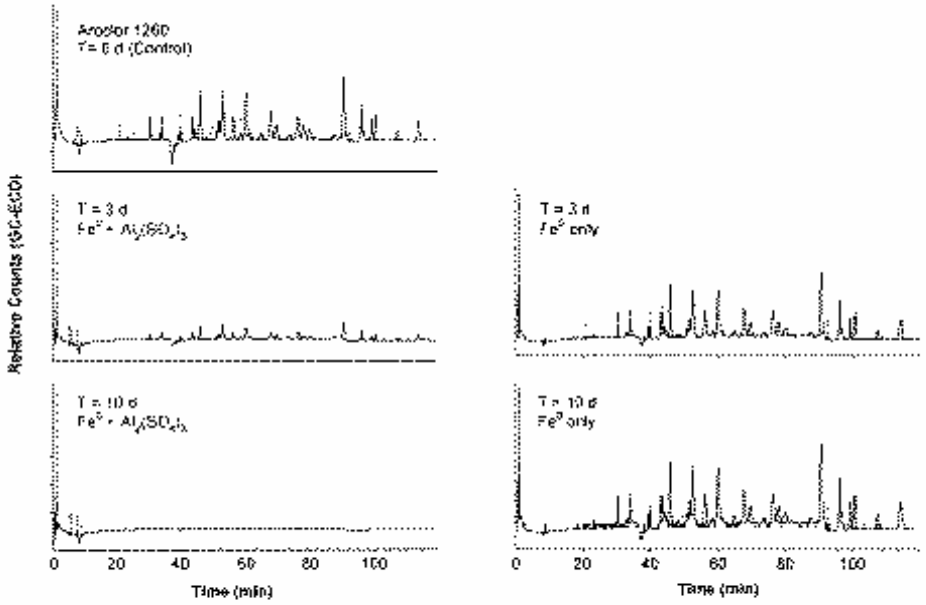

Figure 1. Effects of aluminum sulfate on PCB (Aroclor 1260) destruction by zerovalent iron in cationic surfactant matrix. Chromatographs were generated with GC-ECD.

Solubility experiments revealed that apparent solubility of various PCB congeners could be increased with the increasing didecyl concentrations (up to 1%) (Fig. 2).

Low concentrations of didecyl (0.25%) also increased the mass of Aroclor 1260 (commercial mixture) that dissolved in water (30 mg out of 50 mg placed in 100 mL H_2O**).**

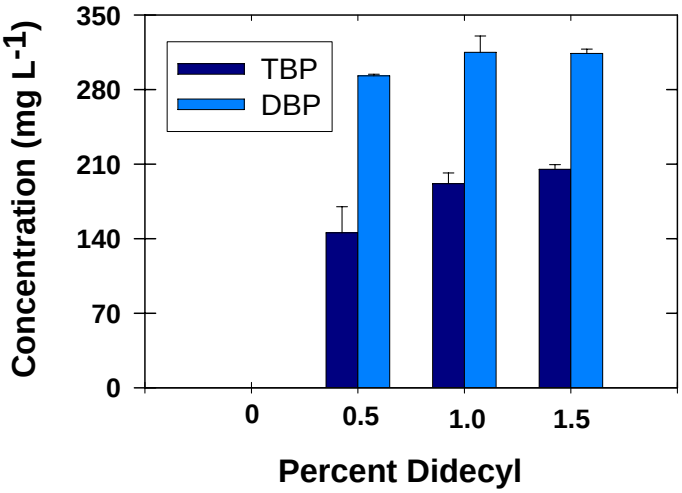

Figure 2. Increase in PCB concentration with increasing didecyl concentrations.

Very rapid removal of PCB mixture occurred with 0.05% Pd was used with iron (Fig. 3).

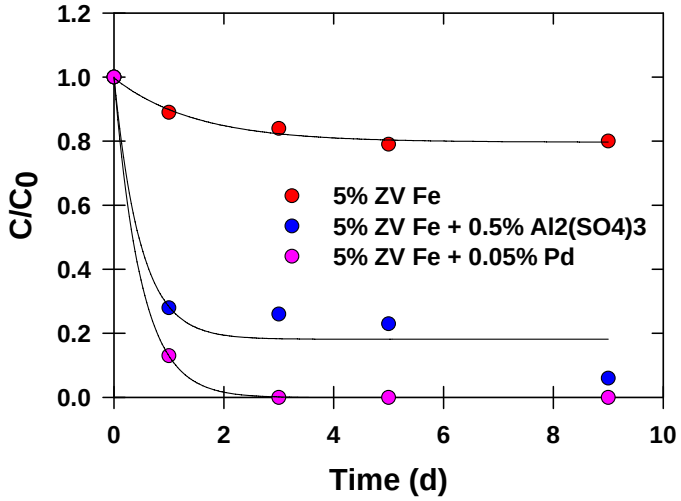

Figure 3. Destruction kinetics of PCBs with zerovalent iron with and without aluminum sulfate or palladium.

Extraction of iron surface revealed that most of the removal occurring was a result of adsorption and not dechlorination. Subsequent ongoing experiments are using a secondary treatment of peroxide or permanganate to oxidize adsorbed PCBs.

Initial Conclusion from First Years Work

- An optimum value of 1% didecyl was observed for increasing PCB congeners solubility. However, dissolution of solid-phase Aroclor 1260 was observed with only 0.25% didecyl.

- Experiments with Aroclor1260 and Fe^0 alone in a surfactant matrix indicate adsorption is occurring**.**

- Experiments with Aroclor1260, Fe^0, didecyl, and catalyst ($Al_2(SO_4)_3$) indicates rapid removal of PCBs from solution but most of this loss is a result of adsorption. Increased removal rates were obtained when Pd was used**.** Using a secondary treatment of iron plus peroxide appears to remove adsorbed PCBs. This treatment train will be pursued in future proposals.